

REMARKS

In view of the preceding amendments and the comments which follow, and pursuant to 37 C.F.R. § 1.111, amendment and reconsideration of the Official Action of February 13, 2003 is respectfully requested by Applicants.

Summary

Claims 1 – 16 stand rejected. Claim 1 has been amended. No new matter has been introduced as a result of this amendment. Claims 1 – 16 remain pending following entry of the present amendments and remarks.

Interview Summary

The Examiner indicated in the Advisory Action mailed on April 26, 2004, that the Applicant's After Final Office Action response failed to place the above identified application in condition for allowance. The phone interview revolved over the rejection of claims 1 – 16 under 35 USC 103 (a) as being unpatentable over US Patent Publication 2002/0034055 to Seyama et al in view of Mack et al. (US 6,462,919) and in further view of Torn et al. (US 6,447,689).

During the interview, Applicants revisited with the Examiner the remarks and claims previously submitted in the April 14 response in conjunction with the issues raised in the Advisory Action.

The Examiner pointed out that the "a bottom of the recess lying in the nonmagnetic layer" feature reads upon the Mack's reference that discloses that not all of the nonmagnetic interlayer is removed so as to prevent any of the free layer from accidentally being etched away. Applicants noted that Mack is silent about the thickness of the remaining nonmagnetic layer as long as the remaining thickness is less than the critical pinning thickness of the exchange tab material. Further, Applicants pointed out to the Examiner that the claimed recessed nonmagnetic layer portion has been defined in the specification as a back layer exhibiting a spin filter effect. This spin filter effect is not taught or suggested by Mack or by the second Torn reference, and thus a corresponding claim amendment would be distinguishable from Mack and

Torng. The Examiner has also acquiesced to the fact that the Torng reference discloses a recess lying on the top of a non-magnetic seed layer, and thus does not read on the claimed feature.

Second, the Examiner stated that a detailed description of the reasons and evidence of unexpected results must be provided for the additional sensitivity argument. We also relayed to the Examiner that such detailed description of the reasons can be found in the specification.

Accordingly, Applicants present an amendment to pending claim 1 that would render it distinguishable from the cited references. The amended claim 1 now recites "a portion of the nonmagnetic layer corresponding to the bottom face of the recess functions as a back layer exhibiting a spin filter effect, thereby improving a rate of change in a resistance in the magnetic sensing element."

In view of the above discussion, and as suggested by the Applicant and agreed by the Examiner, Applicant hereby submits an amended claim 1 to clarify the claimed invention and to remove any ambiguity that may have been the basis for the rejection.

Rejection under 35 U.S.C. § 103

In the next paragraphs, Applicants submit a revised version of the previously submitted but not entered response, in view of the above interview summary.

The Examiner has rejected claims 1, 2, 7, and 13 - 16 under 35 U.S.C. § 103 (a) as being unpatentable over US Patent Publication 2002/0034055 to Seyama et al in view of Mack et al. (US 6,462,919) and in further view of Torng et al. (US 6,447,689). The pending claim 1 relates to a magnetic sensing element which comprises a laminate. The laminate includes a first antiferromagnetic layer, a pinned magnetic layer, a nonmagnetic conductive layer, a free magnetic layer, a nonmagnetic interlayer, a ferromagnetic layer, and a second antiferromagnetic layer, which magnetically couples with the ferromagnetic layer to orient a magnetization of the ferromagnetic layer in a predetermined direction. Further, claim 1 recites that "the laminate has a recess extending through the second antiferromagnetic layer and the

ferromagnetic layer, a bottom face of the recess lying in the nonmagnetic interlayer, a width of the bottom face in a track width direction being equal to a track width" and that "a portion of the nonmagnetic layer corresponding to the bottom face of the recess functions as a back layer exhibiting a spin filter effect, thereby improving a rate of change in a resistance in the magnetic sensing element"

Thus, as claimed the nonmagnetic interlayer has a remaining portion that corresponds to the bottom face of the recess, and which is, as stated above, sequentially layered on top of the free layer. Applicants submit that this structure of the magnetic sensing element is not taught or suggested by any of the references cited, and that no motivation for combining the teachings of Seyama and Mack with that of Torng may be established.

Seyama does not teach or suggest a recess which extends through the second antiferromagnetic layer and the ferromagnetic layer in which the bottom face of the recess lies in the nonmagnetic interlayer. As for Mack, Mack discloses that not all of the nonmagnetic interlayer is removed so as to prevent any of the free layer from accidentally being etched away. Thus, Mack is silent about the thickness of the remaining nonmagnetic layer as long as the remaining thickness is less than the critical pinning thickness of the exchange tab material.

Applicants structure of the laminate provides the nonmagnetic interlayer 16 to function as a protective layer for the free magnetic layer 15 in the region corresponding to the track width T_w . In addition, by forming a nonmagnetic interlayer 16 using a conductive material, the nonmagnetic interlayer 16 can further function as back layer exhibiting a spin filter effect (See page 51, line 27 to page 52, line 5). Typically, a giant magnetoresistance (GMR) effect is mainly caused by a "spin-dependent scattering" of electrons. That is, the GMR effect is obtained using the difference between the mean free path λ^+ of the conduction electrons having a spin parallel to the magnetization direction of a magnetic material, i.e., a free magnetic layer (for example, spin-up electrons) and the mean free path λ^- of the conduction electrons having a spin antiparallel to the magnetization direction (for example, spin-down electrons).

Further, when a back layer is provided, the spin-up electrons which have passed through a free magnetic layer are transported through the back layer by an additional mean free path determined by the material of the back layer, and then scattered. That is, by providing the back layer, the mean free path of the spin-up electrons is extended by the additional mean free path length (See page 54, line 21 to page 55, line 1). As such, since the nonmagnetic interlayer 16, shown in Fig. 1, functions as a back layer, the mean free path of spin-up conduction electrons can be extended. Therefore, a change in the mean free path of spin-up electrons due to an applied external magnetic field is increased, thus improving the rate of the change in resistance ($\Delta R/R$) in the spin-valve magnetic sensing element (See page 55, lines 2 – 7). Hence, the magnetic sensing element has improved sensitivity to magnetic fields, such as magnetic fields related to stored data. Therefore, the additional sensitivity of the magnetic sensing element due to the laminate recess having a bottom face in the nonmagnetic layer is not disclosed or suggested by Mack.

Further, the Examiner states that in the magnetoresistive device of Seyama in view of Mack the bottom face lies on the free magnetic layer rather than on a magnetic interlayer, but that Torg teaches a magnetoresistive sensor with a recess in which a bottom face lies on a nonmagnetic layer, namely a seed layer 12. During the interview, the Examiner agreed that the Torg reference discloses a recess lying on the top of a non-magnetic seed layer, and thus does not read on the claimed feature.

As such, Claim 1 is therefore not rendered unpatentable by the Examiner cited references, either taken alone or if combined. Claims 2 - 16 are each dependent on claim 1, either directly or indirectly, and are therefore likewise patentable. Applicants therefore respectfully request that the rejections of claims 1 – 16 under 35 U.S.C. § 103(a) be withdrawn.

Conclusion

Applicants submit that this application is now in condition for allowance, and favorable reconsideration of this application in view of the above amendments and remarks is respectfully requested. Allowance of claims 1 - 16 at an early date is earnestly solicited. If, there are additional fees due,

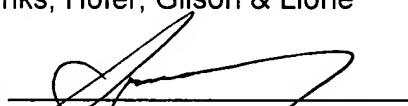
Application No. 10/017,301
Reply to Office Action of February 13, 2004

Applicant requests that this paper constitutes any necessary petition and authorizes the Commissioner to charge any underpayment, or credit any overpayment, to Deposit Account No. 23-1925.

If the examiner finds that there are any outstanding issues which may be resolved by a telephone interview, the Examiner is invited to contact the undersigned attorney at the below listed number

Respectfully submitted,
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